

What is claimed is:

1. A method of developing growth of <111> crystal texture within at least one layer of composition of a magnetic memory cell, the method comprising applying the at least one layer of composition within the memory cell with a level of ion energy that is sufficiently high to enable alignment of the at least one layer of composition to a high degree of quality for the <111> crystal texture.
- 10 2. The method of claim 1, wherein the level of ion energy that is sufficiently high to enable alignment of the at least one layer of composition to the high degree of quality for the <111> crystal texture is determined by the steps of:
 - (a) setting the level of ion energy to a predetermined minimum;
 - (b) applying the at least one layer of composition within the memory cell using the level of ion energy;
 - 15 (c) measuring a degree of quality for the crystal texture that results from applying the at least one layer of composition using the level of ion energy;
 - (d) incrementing the level of ion energy to a higher ion energy level by a predetermined amount and repeating from (b) above until a desired ion energy level has been reached; and
 - (e) setting the level of ion energy approximately to the higher ion energy level used to produce the high degree of quality for the <111> crystal texture within the at least one layer of composition of the magnetic memory cell.
- 25 3. The method of claim 2, further comprising the step of providing at least a tunneling barrier layer in the memory cell prior to applying the at least one layer of composition.
4. The method of claim 2, wherein the level of ion energy set in (f) is the level of ion energy used to produce a highest degree of quality for the crystal texture within the at least one layer of composition of the magnetic memory cell.
- 30 5. The method of claim 1, wherein the magnetic memory cell is a tunneling magneto resistive junction.

6. The method of claim 1, wherein at least one of the layers of composition is a synthetic ferrimagnet.

5 7. The method of claim 6, wherein the synthetic ferrimagnet comprises:
a first ferromagnetic material;
a non-magnetic spacer layer fabricated on top of the first ferromagnetic
material; and
a second ferromagnetic material fabricated on top of the non-magnetic spacer
10 layer and having a magnetic field orientation opposite that of the first ferromagnetic
material.

15 8. The method of claim 6, wherein the synthetic ferrimagnet comprises more
than two ferromagnetic materials, wherein the ferromagnetic materials are separated from one
another by a non-magnetic spacer layer, wherein each successive ferromagnetic material has
a magnetic field orientation opposite that of a previous ferromagnetic material.

20 9. The method of claim 7, wherein the first ferromagnetic material has a
thickness and magnetic field strength which are equivalent to the second ferromagnetic
material.

10. The method of claim 7, wherein the first ferromagnetic material has a different
thickness and magnetic field strength than the second ferromagnetic material.

25 11. A method of manufacturing a top-spin valve TMR junction such that a high
degree of quality of <111> crystal texture is established within layers of composition of the
TMR junction, the method comprising:
applying a ferromagnetic sense layer to a seed layer;
applying the tunneling barrier layer on the ferromagnetic sense layer;
30 using a level of ion energy for applying a ferromagnetic pinned layer on the
tunneling barrier layer, wherein the level of ion energy is sufficiently high to facilitate
alignment of the ferromagnetic pinned layer to the high degree of quality for the
<111> crystal texture; and

applying an antiferromagnetic pinning layer on the ferromagnetic pinned layer, developing the <111> crystal texture within the antiferromagnetic pinning layer due to the proximity of the antiferromagnetic pinning layer to the ferromagnetic pinned layer, and due to their similar metallic properties.

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12. The method of claim 11, wherein the level of ion energy that is sufficiently high to establish the high degree of quality for the <111> crystal texture within the layers of composition of the TMR junction is determined by the steps of:

- (a) setting the level of ion energy to a predetermined minimum;
- 10 (b) providing at least the seed layer, the ferromagnetic sense layer, and the tunneling barrier layer;
- (c) applying at least the ferromagnetic pinned layer above the tunneling barrier layer using the level of ion energy;
- 15 (d) measuring a degree of quality of the crystal texture that results from applying at least the ferromagnetic pinned layer above the tunneling barrier using the level of ion energy;
- (e) incrementing the level of ion energy to a higher ion energy level by a predetermined amount and repeating from (b) above until a desired ion energy level has been reached; and
- 20 (f) setting the level of ion energy to approximately the higher ion energy level used to produce the high degree of quality for the crystal texture above the tunneling barrier layer.

13. The method of claim 12, further comprising the step of applying
25 antiferromagnetic pinning layer above the ferromagnetic pinned layer using the level of ion energy.

14. The method of claim 12, wherein the level of ion energy set in (f) is the level of ion energy used to produce a highest degree of quality for the <111> crystal texture above
30 the tunneling barrier.

15. The method of claim 8, wherein the ferromagnetic sense layer is substituted with a synthetic ferrimagnet.

16. The method of claim 8, wherein the ferromagnetic pinned layer is substituted with a synthetic ferrimagnet.

17. The method of claims 15 and 16, wherein the synthetic ferrimagnet comprises:

5 a first ferromagnetic material;

a non-magnetic spacer layer fabricated on top of the first ferromagnetic material; and

10 a second ferromagnetic material fabricated on top of the non-magnetic spacer layer and having a magnetic field orientation opposite that of the first ferromagnetic material.

18. The method of claim 15 and 16, wherein the synthetic ferrimagnet comprises more than two ferromagnetic materials, wherein the ferromagnetic materials are separated from one another by a non-magnetic spacer layer, wherein each successive ferromagnetic material has a magnetic field orientation opposite that of a previous ferromagnetic material.

19. The method of claim 17, wherein the first ferromagnetic material has a thickness and magnetic field strength which are equivalent to the second ferromagnetic material.

20. The method of claim 17, wherein the first ferromagnetic material has a different thickness and magnetic field strength than the second ferromagnetic material.

21. The method of claim 11, wherein the material for the seed layer is selected from the group consisting of Cu, Ta, Ta, TaN, Ti, TiN, multilayer combinations of Ta/Ru, Ta/NiFe, Ta/Cu, Ta/Ru, Cu/Ru, Ta/Ru, Ta/Cu/Ru, Ta/Ru/FM and Ta/Ru/SF.

22. The method of claim 11, wherein the material for the ferromagnetic sense layer is selected from the group consisting of Ni, Fe and Co.

30 23. The method of claim 11, wherein the material for the tunneling barrier layer is selected from the group consisting of Al₂O₃, SiO₂, Ta₂O₅, SiN₄, AlN_x, and MgO.

24. The method of claim 11, wherein the material for the ferromagnetic pinned layer is selected from the group consisting of Ni, Fe and Co.

25. The method of claim 11, wherein the material for the antiferromagnetic pinning layer is selected from the group consisting of FeMn, NiMn, PtMn, and IrMn.

26. A method of manufacturing a bottom-spin valve TMR junction such that a high degree of quality of <111> crystal texture is established within layers of composition of the TMR junction, the method comprising:

10 using a level of ion energy for applying an antiferromagnetic pinning layer and a ferromagnetic pinned layer to a seed layer, wherein the level of ion energy is sufficiently high to facilitate alignment of the antiferromagnetic pinning layer to the high degree of quality for the <111> crystal texture;

15 applying the tunneling barrier layer on the ferromagnetic pinned layer; and

 applying a ferromagnetic sense layer on the tunneling barrier layer.

27. The method of claim 26, wherein the level of ion energy that is sufficiently high to enable alignment of the layers of composition of the TMR junction to the high degree of quality for the <111> crystal texture is determined by the steps of:

20 (a) setting a level of ion energy to a predetermined minimum;

 (b) providing a seed layer, wherein the seed layer has established the <111> crystal texture;

 (c) applying the antiferromagnetic pinning layer, and the ferromagnetic pinned layer using the level of ion energy;

25 (d) applying the tunneling barrier layer and the ferromagnetic sense layer on the ferromagnetic pinned layer;

 (e) measuring a degree of quality for the <111> crystal texture that results from applying the antiferromagnetic pinning layer and the ferromagnetic pinned layer using the level of ion energy;

30 (f) incrementing the level of ion energy to a higher ion energy level by a predetermined amount and repeating from (b) above until a desired ion energy level has been reached; and

(g) setting the sufficiently high level of ion energy to the higher ion energy level used to produce the high degree of quality for the <111> within the layers of composition of the TMR junction.

5 28. The method of claim 27, wherein the sense layer is applied using the level of ion energy.

29. The method of claim 27, wherein the level of ion energy set in (g) is the higher ion energy level used to produce a highest degree of quality for the <111> crystal texture
10 above the tunneling barrier.

30. The method of claim 26, wherein the ferromagnetic sense layer is substituted with a synthetic ferrimagnet.

15 31. The method of claim 26, wherein the ferromagnetic pinned layer is substituted with a synthetic ferrimagnet.

32. The method of claims 30 and 31, wherein the synthetic ferrimagnet comprises:
20 a first ferromagnetic material;
a non-magnetic spacer layer fabricated on top of the first ferromagnetic material; and
a second ferromagnetic material fabricated on top of the non-magnetic spacer layer and having a magnetic field orientation opposite that of the first ferromagnetic material.

25 33. The method of claim 30 and 31, wherein the synthetic ferrimagnet comprises more than two ferromagnetic materials, wherein the ferromagnetic materials are separated from one another by a non-magnetic spacer layer, wherein each successive ferromagnetic material has a magnetic field orientation opposite that of a previous ferromagnetic material.

30 34. The method of claim 32, wherein the first ferromagnetic material has a thickness and magnetic field strength which are equivalent to the second ferromagnetic material.

35. The method of claim 32, wherein the first ferromagnetic material has a different thickness and magnetic field strength than the second ferromagnetic material.

36. The method of claim 26, wherein the material for the seed layer is selected 5 from the group consisting of Cu, Ta, Ta, TaN, Ti, TiN, multilayer combinations of Ta/Ru, Ta/NiFe, Ta/Cu, Ta/Ru, Cu/Ru, Ta/Ru, Ta/Cu/Ru, Ta/Ru/FM and Ta/Ru/SF.

37. The method of claim 26, wherein the material for the ferromagnetic sense 10 layer is selected from the group consisting of Ni, Fe and Co.

38. The method of claim 26, wherein the material for the tunneling barrier layer is selected from the group consisting of Al₂O₃, SiO₂, Ta₂O₅, SiN₄, AlN_x, and MgO.

39. The method of claim 26, wherein the material for the ferromagnetic pinned 15 layer is selected from the group consisting of Ni, Fe and Co.

40. The method of claim 26, wherein the material for the antiferromagnetic pinning layer is selected from the group consisting of FeMn, NiMn, PtMn, and IrMn.